May Myat Khine 2012: Optimization of Esterification and Transesterification of High Fatty Acid Raw Material using Box-Behnken Method. Doctor of Philosophy (Chemical Engineering), Major Field: Chemical Engineering, Department of Chemical Engineering. Thesis Advisor: Associate Professor Penjit Srinophakun, Ph.D. 155 pages.

This study was the optimization of both esterification and transesterification of the mixture of palm fatty acid distillate (PFAD) and palm stearin (PS). The initial free fatty acid (FFA) contents of raw oil mixture were 5, 20, 40, 50, 60 and 87% for esterification and 1 and 2% for transesterification. Response surface methodology (RSM) three-level-three-factor and three-level-four-factor Box-Behnken designs were employed to predict the conversion of FFA and fatty acid methyl ester (FAME) as a function of reaction time, wt% of catalyst (based on FFA or triglyceride) and molar ratio of methanol to FFA or triglyceride in oil. In esterification, the experiments for initial 5, 20, 40, 50, 60 and 87% FFA were performed under fixed and varied conditions. The fixed conditions were molar ratio of methanol to triglycerides in oil of 3:1, 60 ºC reaction temperature and 500 rpm stirring rate. The varied parameters were reaction time, wt% of catalyst (based on FFA in oil) and molar ratio of methanol to FFA in oil.

The second order polynomial model was used to predict the optimum condition. The optimum condition parameters to reduce FFA from 5% initially to 1% were 4.5:1 molar ratio of methanol to FFA in oil, 3 wt% sulfuric acid (based on FFA) and 90 min reaction time respectively. The optimum condition for initial 20% FFA was molar ratio of methanol to FFA of 4.6:1 and 2.4 wt% sulfuric acid after 3 h of reaction. The predicted optimum condition for initial 40% FFA was 11.6:1 molar ratio of methanol to FFA, 3.3 wt% sulfuric acid and 5.4 h of reaction. In the optimization of initial 50% FFA esterification, the optimum condition was molar ratio of methanol to FFA of 11.8:1, sulfuric acid loading of 3.7 wt% (based on FFA) and reaction time of 5.3 h. The optimum condition for initial 60% FFA esterification was molar ratio of methanol of FFA of 11.6:1, reaction time of 5.4 h and catalyst based on FFA of 3.5 wt%. For transesterification of initial 1% FFA, this predicted optimum condition was molar ratio of methanol to triglyceride of 8.25:1, KOH concentration of 0.8 wt% (based on triglyceride) and reaction time of 75 min to get 96.7% FAME. For the initial 2% FFA, molar ratio of methanol to triglyceride of 12:1, KOH concentration of 0.82 wt% (based on triglyceride) and reaction time of 30 min to get 96% FAME of initial 2% FFA. The order of important factors were methanol amount > catalyst loading > time for both of 1 and 2% FFA transesterification. According to three-level-four-factor predicted design of initial 5-87% FFA, it can be used to predict the optimum conditions of initial 40, 50 and 60% but not for the initial FFA less than 40%.

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